

Synthesis of Reactive Fragranced Entities and Their Application to Cotton Textiles

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Abstract

The aim of the study was to synthesize fragranced reactive entities followed by their graft to cotton fabric. The cyanuric chloride was chosen for this purpose to utilize its reactivity which was grafted to β -cyclodextrin to generate cavities to load various fragrances in it. The synthesized complex was then encapsulated with various fragrances followed by its application to the cotton fabric. The treated samples, subjected to number of washing cycles as well as exposure to sunlight to study the fragrance retention, were then characterized for β -cyclodextrin content, graft %, tensile properties and olfactometry analysis. The studies of FTIR spectra clearly showed attachment of β -cyclodextrin to cyanuric chloride whereas olfactometry analysis gave an idea of perfume retention onto the fabric even after number of washings and exposure to sunlight.

Keywords

Reactive Entities; β -cyclodextrin; Molecular Encapsulation; Olfactometry

Introduction

Textiles with advanced technology could be much more than the conventional textiles, with new wrinkle free and stain resistant function, to give pleasant aroma, antibacterial properties and many more. Such textiles are called smart textiles. In Germany five million people suffer from neurodermitis, two million from psoriasis, and further three million from dermal diseases of occupational origin (like hairdresser's allergic reactions on the hands, athlete's foot, etc.). The corresponding clothing (underwear, gloves, socks) can be loaded with the necessary antifungal, antihistaminic, and anti-inflammatory agents via β -cyclodextrin. A further application is for towels which start smelling after drying one's hands. Similarly, bed linen may release a pleasant odor after lying on bed.

Smells can evoke emotional reactions. Numerous studies, conducted around the globe, indicate that

odours have an impressive and measurable effect on people's behavior and mood state. The use of herbs in medicine spread from ancient Indian civilization to other parts of the world. This ancient system of herbal medicinal therapy with modern scientific understanding and experimentation forms the basis of "Aromatherapy" which as the name suggests is a holistic therapy using fragrant essential oils to treat body and mind. Insertion of Fragrance to textiles, one such immaculate magnanimous entry into any textile culture, is the process where we enhance the value of the product by adding some incentives to it.

To make aromatherapeutic textiles, β -cyclodextrin was the first choice as the host molecule, because β -cyclodextrin molecules are capable of forming inclusion compounds with organic compounds that fit into their own cone-shaped hydrophobic cavities. Cyclodextrins (α -, β - and γ -CD) are formed during the enzymatic degradation of starch. These are non-reducing, crystalline, water soluble, cyclic, oligosaccharides. β -Cyclodextrin is the most accessible, the lowest-priced and generally the most useful.

The present work was, therefore aimed at attaching β -cyclodextrin to cyanuric chloride to form colourless reactive entities and then grafting it to cotton, utilizing the inclusion properties of the β -cyclodextrin to form inclusion complexes with various aromas viz. Citronella oil, Jasmine oil and various solvent based fragrances. Cyanuric chloride was chosen due to reactivity of number of chlorine atoms under different experimental conditions giving number of products. Finally, the characterization of the prepared entities and final products i.e. treated cotton samples was done. The attached β -cyclodextrin was measured quantitatively by Phenolphthalein absorption test. The inclusive aromas were measured by olfactometry analysis. The effect of β -cyclodextrin was examined for % graft and tensile properties.

Material

Plain RFD (Ready for Dyeing) cotton fabric was kindly provided by Arvind Ltd., a composite textile unit, Ahmedabad. β -cyclodextrin was provided by the National Chemicals Ltd., Vadodara. N-Methyl 2-Pyrrolidone, Acetone, sodium chloride, sodium carbonate, and Sodium hydroxide were purchased from Sulab Chemicals, Vadodara. Essential oils and Perfumes such as Citronella oil, Jasmine oil, Lonkom perfume and Gambit perfume were purchased from various perfumery industries like Sagar Aromatics, Mumbai; Hakimchichi & sons, Surat.

Apparatus & Equipments

- Mettler Toledo Digital Weighing balance, Precision Weighing balances Ltd.
- Nicolet iS10FT-IR spectrometer, Thermo scientific Ltd.
- Spectrascan 1500A, Premier colorscan Pvt. Ltd.
- Lloyd Tensile Tester, U.K.
- High Temperature High Pressure Beaker dyeing machine, R. B. Electronics Pvt. Ltd.
- Launderometer with microprocessor, R. B. Electronics Pvt. Ltd.

Experimental Methods

Synthesis of Reactive Entities

β -cyclodextrin is capable of forming inclusion complexes with various guest molecules like medicines, sunscreen agents, insect repellents, perfumes, etc. The reactive fragranced entities prepared here were used for the finishing of the white cotton fabrics. 25 ml of Sodium hydroxide was taken to make approximately 2 gms of β -cyclodextrin alkaline. The alkaline β -cyclodextrin was added to the solution of cyanuric chloride in the ratio of 1:1 at 4-5°C for 15 minutes. The resultant mixture was then extracted using solvent extraction method and then collected and oven dried till constant weight.

Encapsulating the Fragrances into the Synthesized Entities

The complex was weighed according to the application concentration. Pre-measured fragrances in various amounts viz. 10%, 20% and 60% (on weight of complex) were then sprayed on the complex taken followed by air drying to evaporate the volatile content of the fragrance. Thus perfume loaded complex (known as fragranced reactive entities) was

then further used for application on the cotton fabrics.

Application of Fragranced Reactive Entities to Cotton Fabric

The cotton fabric was treated with CC-CD complex (with and without fragrance encapsulation) in a similar manner of the dyeing cycle of cold brand reactive dyes for cotton.

The application concentrations of complex were 1%, 3% and 5% (owf). The exhaustion of the complex was completed in four parts using 100gpl sodium chloride within 2 hours in a closed chamber. The exhausted complex was further fixed using 30gpl sodium carbonate within complete 1 hour. The treated samples were then rinsed, washed and soaped followed by complete drying. All the samples treated with complex (i.e. with and without fragrances) were then analyzed for graft % as well as tensile strength. All the samples were also sent for olfactometry analysis for fragrance retention on it. The β -Cyclodextrin content of all the treated as well as untreated samples was measured by phenolphthalein absorption test.

Washing of the Treated Textiles

The perfumes are volatile in nature. Thus, the intensity of fragrances gets reduced day by day by a wear or wash. All the treated samples were examined for fragrance retention after number of washings which gave idea of the fragrance retention on clothing usage in day to day routine life. The washings were given according to the ISO 105-C10, 2006 standards using 5 gpl soap solution and 2 gpl soda ash solution at 60°C for 30 minutes in Launderometer. This procedure was repeated 5 times to examine the fragrance retention after the washing procedure. After each washing the samples were sent for olfactory analysis to panelists for fragrance intensity ratings.

Characterization of Synthesized Reactive Entities

The prepared colourless reactive entities were characterized by Fourier transformed Infrared Spectroscopy (FTIR) to examine the attachment of β -cyclodextrin to the cyanuric chloride qualitatively. The characterization of the prepared entities cannot give idea of the result on the fabric. Thus, characterization of the treated samples was also done, which has been discussed later.

Fourier transformed Infrared Spectroscopy (FTIR) is the recent version of the Infrared spectroscopy. This test was done on Nicolet iS10FT-IR Spectrometer from Thermo scientific, USA.

Characterization of Treated Textiles

1) % Graft:

The graft percent was calculated from the add-on of the entities.

2) Tensile Strength:

The tensile strength of the fabric gets affected by the presence of the β -Cyclodextrin to some extent. Thus, tensile strength of all the samples was measured on Lloyd Tensile Tester, UK.

3) Olfactometry Analysis:

It is one kind of sensory analysis to establish the odour concentration which employs a group of panelists. The odour concentration or the intensity was divided into the following categories according to the intensity:

- 0 → No odour
- 1 → Very weak
- 2 → Weak
- 3 → Medium strong
- 4 → Strong
- 5 → Very strong

This method was applied in the laboratory and was done by a series of suitably trained panelists.

4) Phenolphthalein Absorption Test:

The solution was prepared by aqueous ethanol and Na_2CO_3 with phenolphthalein stock solution. The samples were put together with the testing solution into 25 ml Erlenmeyer flask. They were shaken to attain complex equilibrium. For each point on the calibration function, one blank fabric (untreated material) was included. Measurement was done with the 1500 Premium colors can spectrophotometer from Thermoscientific at maximum absorption of phenolphthalein. The time demanded by the complexing reaction and the influence on analysis time requirement was set 20 min.

Results and Discussion

Characterization of Synthesized Reactive Entities

1) FTIR Spectroscopy

Fourier transformed Infra red spectroscopy of the samples was done using Nicolet iS10FT-IR

spectrometer, Thermo scientific Ltd. Figure 1, 2 and 3 show the FTIR spectras of cyanuric chloride, β -Cyclodextrin and the colourless reactive entities i.e. cyanuric chloride- β -Cyclodextrin complex respectively. Cyanuric chloride showed sharp peaks around 1398 cm^{-1} , 1684 cm^{-1} and 755 cm^{-1} indicating C-N, C=N and C-Cl stretching respectively. A broad band around 3290 cm^{-1} due to O-H stretching and at 2927 cm^{-1} due to C-H stretching were found in β -Cyclodextrin. The medium peaks at 1414 cm^{-1} and 1334 cm^{-1} also showed the C-H bending vibrations of alkane i.e. CH_2 in case of β -Cyclodextrin. The peaks of 3290 cm^{-1} and 2927 cm^{-1} showed the presence of O-H stretching and C-H stretching respectively of β -Cyclodextrin in the FTIR spectra of cyanuric chloride- β -Cyclodextrin complex. The sharp peaks of chlorine atom i.e. 776 cm^{-1} and 756 cm^{-1} was found in FTIR spectra of cyanuric chloride which reduced and showed a medium peak at 755 cm^{-1} in FTIR spectra of cyanuric chloride- β -Cyclodextrin complex.

Characterization of Treated Textiles

1) Effect of Complex Concentration on Graft % of the Fabric Treated with Synthesized Reactive Entities (without perfume encapsulation)

Table I represents the graft % after treating it with the Cyanuric Chloride- β -Cyclodextrin complex in various concentration viz., 1%, 3% and 5% (owf). Cyanuric Chloride contains three chlorine atoms which have tendency to get replaced by other molecules. Here in this case β -Cyclodextrin was used to replace one chlorine atom of the Cyanuric chloride. It can be seen from the table that the graft % increased with an increase in CC-CD complex concentration on the fabric. This was due to more number of sites of CC-CD complex available to hydroxyl group of cotton fabric.

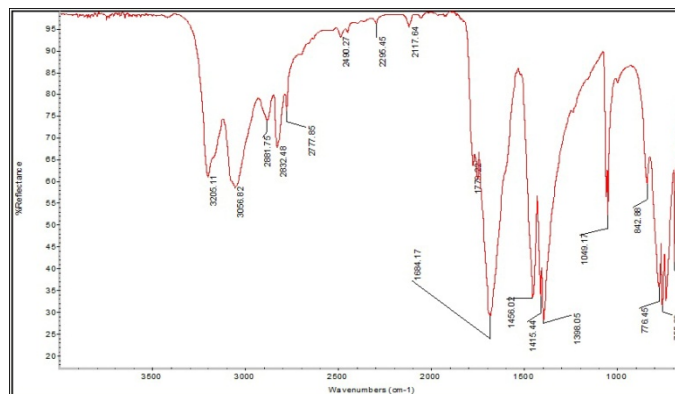


FIG. 1 FTIR SPECTRA OF CYANURIC CHLORIDE

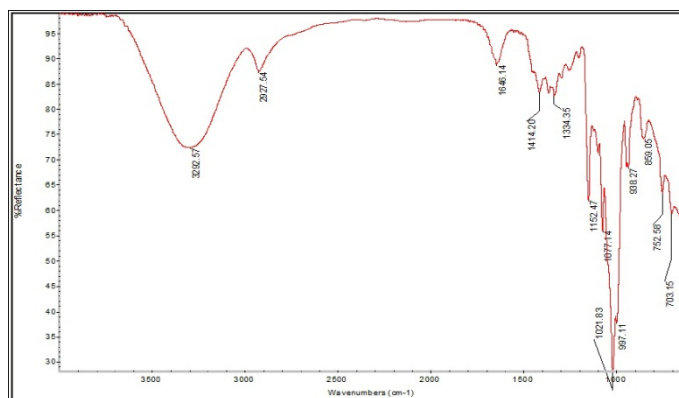
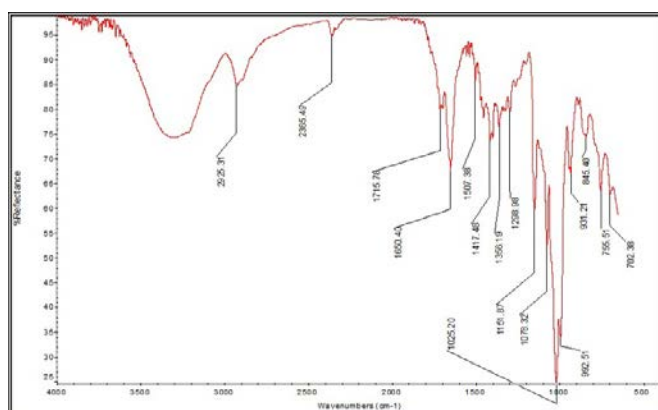
FIG. 2 FTIR SPECTRA OF β -CYCLODEXTRINFIG. 3 FTIR SPECTRA OF 1:1 CYANURIC CHLORIDE- β -CYCLODEXTRIN COMPLEX

TABLE I EFFECT OF COMPLEX CONCENTRATION ON GRAFT % OF THE FABRIC TREATED WITH CC-CD COMPLEX

Sr. No.	Application Concentration of CC-CD complex	Graft %
1.	1%	3.23
2.	3%	5.36
3.	5%	7.28

Note: Molar Ratio of Cyanuric Chloride to β -Cyclodextrin was 1 : 1. CC-CD complex is Cyanuric Chloride- β -Cyclodextrin complex.

2) Effect of β -Cyclodextrin Grafting on Tensile Properties of Fabric Treated with Synthesized Reactive Entities (without perfume encapsulation)

Table II represents the effect of various application concentration of CC-CD complex on the tensile properties of the fabric. The β -Cyclodextrin works as a plasticizer. It can be seen that there is an increase in % elongation compared to the bleached cotton sample for all the application concentrations which directly reflected on the Tensile strength of the fabrics. The degree of rise was in the order of 1% > 3% > 5% application concentrations.

TABLE II EFFECT OF β -CYCLODEXTRIN GRAFTING ON TENSILE PROPERTIES OF FABRIC TREATED WITH CC-CD COMPLEX

Application Concentration of CC-CD complex	Tensile Strength (kgf)	Elongation at Break (%)
Bleached cotton	24.51	2.99
1%	34.55 (40.95)	5.68 (90.01)
3%	30.42 (24.13)	4.50 (50.50)
5%	27.12 (10.63)	3.27 (9.32)

Note: Values in the parenthesis indicate corresponding % gain in Tensile strength and Elongation at break (%) compared to bleached cotton sample

This was due to the increased segmental mobility between the polymeric chains.

3) Quantitative Analysis of β -Cyclodextrin Content on the Treated Fabric by Phenolphthalein Inclusion Test

Table III shows the β -Cyclodextrin Content of fabric treated with various concentrations of CC-CD complex encapsulated with perfumes. Phenolphthalein was used as an indicator to measure β -Cyclodextrin concentration on the fabric. The difference in the colour intensity of phenolphthalein is proportional to the β -Cyclodextrin content at lower concentration i.e. between 0.0 – 1.0 $\times 10^{-4}$ moles/lit. The table represents quantity of the β -Cyclodextrin present in the fabric after grafting it to the CC-CD complex. The β -Cyclodextrin content decreased with an increase in the concentration of complex studied i.e. from 1% to 5%. This was due to the loss in graft with an increase in the application complex concentrations. The difference in the pink colour of phenolphthalein for varied concentrations of the complex was not clearly visible by naked eyes, which were found out from spectrophotometers.

4) Effect of Perfumes and Their Concentrations on Graft % of the Treated Fabric

Table IV shows the effect of perfume concentration on graft % of the fabric treated with perfume encapsulated CC-CD complex compared with the control sample (i.e. the cotton fabric treated with CC-CD complex without encapsulating perfume). The weight of the fabric should get increased as discussed in Table II. But it was not found in this case.

TABLE III QUANTITATIVE ANALYSIS OF β -CYCLODEXTRIN CONTENT ON THE FABRIC BY PHENOLPHTHALEIN INCLUSION TEST

Type of Perfume	Perfume Conc.	Application Conc of CC-CD complex	β -Cyclodextrin Content (mol/lit)
Citronella Extract Oil	10%	1%	8.58×10^{-5}
		3%	6.58×10^{-5}
		5%	3.18×10^{-5}
	20%	1%	8.50×10^{-5}
		3%	6.50×10^{-5}
		5%	2.84×10^{-5}
	60%	1%	8.10×10^{-5}
		3%	6.42×10^{-5}
		5%	2.50×10^{-5}
Jasmine Extract Oil	10%	1%	9.58×10^{-5}
		3%	6.94×10^{-5}
		5%	2.92×10^{-5}
	20%	1%	8.66×10^{-5}
		3%	6.76×10^{-5}
		5%	2.58×10^{-5}
	60%	1%	8.10×10^{-5}
		3%	6.50×10^{-5}
		5%	2.50×10^{-5}
Lonkom Perfume	10%	1%	8.58×10^{-5}
		3%	6.66×10^{-5}
		5%	2.84×10^{-5}
	20%	1%	8.10×10^{-5}
		3%	6.42×10^{-5}
		5%	2.66×10^{-5}
	60%	1%	7.96×10^{-5}
		3%	6.26×10^{-5}
		5%	2.34×10^{-5}
Gambit Perfume	10%	1%	9.50×10^{-5}
		3%	6.98×10^{-5}
		5%	2.58×10^{-5}
	20%	1%	8.58×10^{-5}
		3%	6.58×10^{-5}
		5%	2.50×10^{-5}
	60%	1%	8.01×10^{-5}
		3%	6.42×10^{-5}
		5%	2.18×10^{-5}

Note: *Control sample was the cotton fabric treated with CC-CD complex (without loaded with perfume). Value of β -Cyclodextrin Content for the control sample was 0.50×10^{-5} mol/lit.

Table IV reveals this fact in the form of decrease in the graft % of the fabric. The reduction increased with an increase in the concentration of complex i.e. from 1% to 5% applied onto it. Due to increase in weight of the loaded CC - β -CD complex, its attachment to the fabric was reduced due to steric factor. It can be clearly noticed that the gambit perfume showed maximum loss while the lonkom perfume showed the least.

TABLE IV EFFECT OF PERFUMES AND THEIR CONCENTRATIONS ON % GRAFT OF THE FABRIC

Type of Perfume	Perfume Conc.	Application Conc. of CC-CD complex	Graft %	Loss in Graft Percent compared to correspondin g control sample (%)
Citronella Extract Oil	10%	1%	3.09	4.09
		3%	4.93	7.87
		5%	6.69	8.10
	20%	1%	2.97	7.90
		3%	4.68	12.54
		5%	6.20	14.72
	60%	1%	2.77	13.98
		3%	4.25	20.59
		5%	5.33	26.70
Jasmine Extract Oil	10%	1%	3.03	6.09
		3%	4.95	7.56
		5%	6.88	5.48
	20%	1%	2.92	9.50
		3%	4.63	13.46
		5%	6.62	8.95
	60%	1%	2.73	15.49
		3%	4.16	22.35
		5%	5.05	30.56
Lonkom Perfume	10%	1%	3.10	3.89
		3%	5.08	5.20
		5%	6.69	7.98
	20%	1%	3.01	6.56
		3%	4.87	9.08
		5%	6.34	12.84
	60%	1%	2.89	10.25
		3%	5.20	16.74
		5%	5.69	21.80
Gambit Perfume	10%	1%	3.02	6.45
		3%	4.88	8.80
		5%	6.33	12.95
	20%	1%	2.84	11.87
		3%	4.52	15.68
		5%	5.68	21.90
	60%	1%	2.57	20.39
		3%	3.94	26.46
		5%	4.89	32.78

Note: *Control sample was the cotton fabric treated with CC-CD complex (without loaded with perfume). Values of graft % for control sample were 3.23, 5.36 and 7.28 for 1%, 3% and 5% application concentrations of CC - β -CD complex respectively.

5) Effect of Perfumes and Their Concentrations on Tensile Properties of the Treated Fabric

The grafting of CC-CD complex to cotton increased its tensile strength due to intermolecular bonding (Table II). Higher concentration of CC-CD reduced the extent of enhancement in tensile strength probably because of higher inter CC-CD reaction which led to lesser availability of the complex to react with cotton. But interestingly, the introduction of perfume in the CD cavity reduced

the strength of cotton (Table V), which may be due to the plasticizing effect of the solvents base of the perfumes. The gambit perfume in the case of solvent based fragrances showed the highest loss than all the other fragrances used while Lonkom perfume showed the least effect.

6) *Olfactometry Analysis of Perfume Intensity with Respect to Time (Days)*

Table VI represents the olfactometry analysis of the fragrance present in the cotton fabric treated with perfume encapsulated CC-CD complex after number of days of evaluation. It can be easily seen that the fragrance intensity decreased day by day irrespective of the quantity and type of the perfume loaded as well as the concentration of complex.

TABLE V EFFECT OF PERFUMES AND THEIR CONCENTRATIONS ON TENSILE PROPERTIES OF FABRIC TREATED WITH CC-CD COMPLEX

Type of Perfume	Perfume Concentration	Application Concentration of CC-CD complex	Tensile Strength (kgf)	Loss in Tensile Strength (%)	Elongation at Break (%)	Gain in Elongation at Break (%)
Citronella Extract Oil	10%	1%	25.08	27.41	6.30	10.84
		3%	25.39	16.54	5.38	19.56
		5%	24.65	9.1	4.25	30.08
	20%	1%	29.25	15.35	6.02	6.07
		3%	27.43	9.84	4.98	10.75
		5%	25.70	5.23	3.88	18.62
	60%	1%	31.75	8.1	5.88	3.44
		3%	28.80	5.33	4.77	6.05
		5%	26.41	2.6	3.63	10.89
Jasmine Extract Oil	10%	1%	23.98	30.6	6.38	12.41
		3%	24.66	18.95	5.47	21.59
		5%	24.29	10.44	4.32	32.12
	20%	1%	28.08	18.72	6.09	7.21
		3%	27.29	10.3	5.05	12.22
		5%	25.46	6.12	4.00	22.36
	60%	1%	30.98	10.33	5.91	4.11
		3%	28.58	6.05	4.9	6.54
		5%	26.14	3.62	3.69	12.95
Lonkom Perfume	10%	1%	26.33	23.8	6.19	8.96
		3%	26.61	12.53	5.20	15.54
		5%	25.11	7.41	4.10	25.41
	20%	1%	30.22	12.53	5.94	4.6
		3%	28.37	6.75	4.88	8.47
		5%	26.05	3.94	3.70	13.29
	60%	1%	32.19	6.84	5.86	3.09
		3%	29.24	3.88	4.72	4.85
		5%	26.56	2.06	3.51	7.2
Gambit Perfume	10%	1%	23.54	31.87	6.58	15.78
		3%	23.97	21.2	5.65	25.63
		5%	23.80	12.24	4.53	38.4
	20%	1%	28.30	18.09	6.16	8.42
		3%	26.85	11.74	5.10	13.3
		5%	25.27	6.83	4.00	22.25
	60%	1%	30.89	10.59	5.96	4.96
		3%	28.53	6.21	4.82	7.09
		5%	26.07	3.88	3.67	12.10

Note: *Control sample was the cotton fabric treated with CC-CD complex (without loaded with perfume). Values of Tensile strength for control sample were 34.55, 30.42 and 27.12 and of % Elongation at break were 5.68, 4.50 and 3.27 for 1%, 3% and 5% application concentrations of CC-β-CD complex respectively.

TABLE VI OLFACTOMETRY ANALYSIS OF PERFUME INTENSITY WITH RESPECT TO TIME (DAYS)

Type of Perfume	Perfume Conc.	Number of Days →	5 th Day	10 th Day	20 th Day	30 th Day
		Application Conc. of CC-CD complex ↓				
Citronella Extract Oil	10%	1%	4	3	1	1
		3%	4	3	2	1
		5%	4	3	2	2
	20%	1%	4	3	2	2
		3%	4	3	3	1
		5%	5	4	3	2
	60%	1%	5	4	4	3
		3%	5	4	4	3
		5%	5	5	4	4
Jasmine Extract Oil	10%	1%	3	2	1	0
		3%	3	2	1	0
		5%	4	3	3	1
	20%	1%	3	3	2	1
		3%	4	3	2	1
		5%	4	4	3	2
	60%	1%	4	3	3	1
		3%	4	4	3	2
		5%	5	4	3	2
Lonkom Perfume	10%	1%	4	3	2	1
		3%	4	3	3	1
		5%	4	4	3	2
	20%	1%	4	3	2	1
		3%	4	4	3	2
		5%	5	4	4	3
	60%	1%	5	4	3	1
		3%	5	4	3	3
		5%	5	4	4	3
Gambit Perfume	10%	1%	3	2	1	0
		3%	4	3	1	1
		5%	4	3	2	1
	20%	1%	4	2	1	1
		3%	4	3	2	1
		5%	4	4	3	1
	60%	1%	5	4	3	2
		3%	5	4	3	2
		5%	5	4	4	2

Table VI reveals that the perfumes could withstand more than 30 days on the fabric in most cases. In all the individual case, the intensity of perfumes almost kept the evaluation in the initial days which gradually decreased with increase in number of days of evaluation. It can be easily observed that Citronella extract oil gave good results while the Gambit perfume compared to the other two perfumes studied. This was due to the characteristic property of β -cyclodextrin that it cannot form complex with the moieties of all sizes.

7) *Olfactometry Analysis of Perfume Intensity with Respect to Washing Cycles*

Table VII represents the effect of number of washes on the intensity of the perfume present in the cotton fabric treated with perfume encapsulated CC-CD complex. This assessment gave an idea

about the life of perfume on number of washing cycles given to the fabric in the day to day routine life.

It is obvious that the fragrance intensity decreased with the given every wash irrespective of the quantity and type of the perfume loaded as well as the concentration of the complex studied. This was because of the volatile nature of the perfumes.

Table VII shows the olfactory analysis of the fabrics done before washings as well. The ratings revealed that all the fabrics gave very strong sensation of the perfume before washing, which remains almost same even on first wash. Jasmine extract oil was found to be more sensitive while Lonkom perfume withstood more number of washing cycles as compared to the other two perfumes studied.

TABLE VII OLFACTOMETRY ANALYSIS OF PERFUME INTENSITY AFTER NUMBER OF WASHING CYCLES

Type of Perfume	Perfume Concentration	Number of Washings →	Before Washing	1 st	2 nd	3 rd	4 th	5 th
		Application Concentration of CC-CD complex ↓						
Citronella Extract Oil	10%	1%	4	3	2	1	1	0
		3%	4	3	2	2	1	1
		5%	5	4	3	3	2	1
	20%	1%	4	4	3	2	1	1
		3%	5	4	3	2	2	1
		5%	5	4	3	3	2	1
	60%	1%	5	4	3	2	1	1
		3%	5	4	4	3	2	1
		5%	5	5	4	3	3	2
Jasmine Extract Oil	10%	1%	4	3	2	1	1	0
		3%	4	3	2	1	1	0
		5%	4	3	2	1	1	0
	20%	1%	4	3	2	1	1	0
		3%	4	4	3	2	1	1
		5%	5	4	3	2	2	1
	60%	1%	4	4	3	1	1	1
		3%	5	4	4	3	2	1
		5%	5	4	4	3	2	1
Lonkom Perfume	10%	1%	4	3	2	2	1	1
		3%	5	4	3	2	1	1
		5%	5	4	3	3	2	1
	20%	1%	5	4	3	3	2	1
		3%	5	4	3	3	2	1
		5%	5	4	4	3	2	2
	60%	1%	5	4	3	3	2	2
		3%	5	5	4	3	3	2
		5%	5	5	4	4	3	3
Gambit Perfume	10%	1%	4	3	2	1	1	0
		3%	4	3	2	1	1	0
		5%	5	4	3	2	1	0
	20%	1%	4	4	3	2	1	1
		3%	4	4	3	2	2	1
		5%	5	4	4	3	3	2
	60%	1%	4	4	3	2	1	1
		3%	5	4	4	3	3	2
		5%	5	4	4	3	3	2

This was basically due to the properties of the perfumes used. Unfortunately the exact structures of the perfumes were not available. The perfume intensity gradually decreased from the first wash to the fifth wash cycle. Based on the above discussions, it can be noted that the number of washes affected the perfume intensity to a very large extent.

Conclusions

As a host molecule β -Cyclodextrin could be well grafted to cyanuric chloride to form colourless reactive entities utilizing the reactive nature of cyanuric chloride. The grafting was characterized by FTIR analysis. The grafted β -Cyclodextrin was successfully attached to cotton fabric via cyanuric chloride. Using the inclusion complex forming property of β -Cyclodextrin, various perfumes were successfully encapsulated in CC-CD complex. The characterization

of graft (without perfume encapsulation) showed that β -Cyclodextrin grafting was increased with increase in its application concentration onto cotton whereas it slightly decreased after perfume encapsulation as revealed by the Phenolphthalein absorption test. The loss in β -Cyclodextrin content was found to drop with increase in the application concentration of complex on textiles. The grafted textiles without perfume inclusion showed higher elongation at break (maximum 90%) and tensile strength (maximum 40%) whereas the perfume encapsulated textiles showed loss in tensile properties depending on characteristics of perfumes used. The extent of perfume intensity found to be varied for different perfumes. Olfactometry Analysis of the treated samples showed that perfume intensity became weaker with respect to time and washing cycles. The intensity varied depending on the type and concentration of the perfumes used.

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